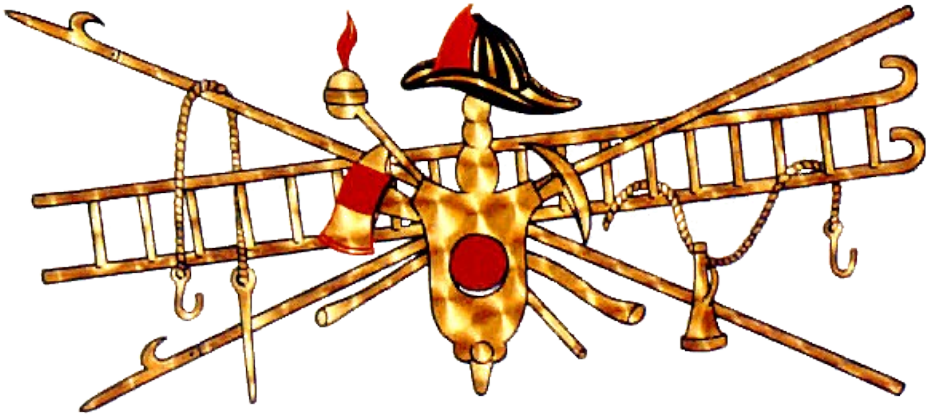
State Fire Training
Confined Space Awareness



Regulations

- February 1994 CAL-OSHA enacted their final rule for confined space relations
  - Title 8, California Code of Regulations (CCR), General Industry Safety Orders (GISO), Sections 5156, 5157, 5158
- Outside California FED-OSHA has a near identical document
- American National Science Institute (A.N.S.I.) and National Institute for Occupational Safety and health (N.I.O.S.H.) guidelines are also used.*

Fatality Statistics

- Studies reveal that every year approximately 67 preventable deaths occur in confined spaces
- As many as 60% of the deaths to occur would be rescuers*
- Research reveals interesting facts regarding the causes of deaths in confined spaces
  - 65% hazardous atmospheres *
  - 13% engulfment
  - 7% struck by falling objects
  - 6% heat stress/exposure
  - 4% others

Not all will be labeled!

Some will be!

Injury and Illness Prevention

- Safety responsibility
- Compliance/recognition
- Employee-employer communication
- Workplace inspections/evaluation
- Correction of hazards
- Injury/illness investigation
- Training
- Recordkeeping

Definitions of Confined Space

- Confined spaces are subdivided into two groups

1. Confined Space

a) Is large enough and so configured that an employee can bodily enter and perform assigned work; and

b) Has limited or restricted means for entry or exit; and

c) Is not designed for continuous employee occupancy

Permit Required Confined Space

- A permit required space must meet the definition of a confined space plus one of the following:*
  - Contains or has the potential to contain a hazardous atmosphere
  - Contains a material that has the potential for engulfing an entrant
  - Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls, or a floor which slopes and tapers to a smaller cross section or
  - Contains any other recognized serious safety or health hazard

Typical Permit Required Confined Spaces

- Storage tanks
- Pump wet wells
- Degreasers
- Digesters
- Sewers
- Person holes
- Tunnels
- Underground vaults
- Boilers
- Silos
- Vessels
- Grain elevators
- Mixers
- Open topped water tanks
- Water towers
- Enclosures with bottom access
- Rail car tanks

Dangers of Confined Spaces

- Oxygen deficiency
- By-products of previously stored materials
  - Storage tanks retain residue
  - Product is absorbed into tank walls
- Accidental leaks or spills
  - Leaks of substances give off vapors or cause reactions
  - Slip, trip or fall hazard
- Chemical Reactions
  - Accidental mixing of chemicals
  - Drying paint
  - Multiple use tanks

Dangers of Confined Spaces

- Oxidation
  - Rusting of metals
  - Rotting or decomposing organic materials
- Mechanical Operations
  - Welding
  - Painting
  - Cleaning
  - Scraping or sandblasting
  - Missing/stirring operations
  - Recharging of batteries
- Inerting Activities
  - Carbon dioxide (CO_2)
  - Helium (HE)
  - Nitrogen (N_2)

Types of Confined Space Hazards

- Confined space hazards are basically grouped into six groups
  - Atmospheric hazards
  - Physical hazards
  - Engulfment hazar
  - Corrosive hazards
  - Biological hazards
  - Other hazards

VIDEOS

Confined space Awareness (SFD Web Site)

Effects of Hazardous Atmospheres

- Suffocation*
  - 65% of fatalities occurring in confined spaces are a result of hazardous atmospheres *
- Poisoning *
- Explosion/Fire *

Hazardous Atmosphere

- An atmosphere which exposes employees to a risk or death, incapacitation, injury or acute illness from one or more of the following causes
  - O2 level below 19.5% or above 23.5%
  - Flammable gas or vapor in excess of 10% of L.E.L.
  - Airborne combustible dust at a concentration that obscures vision at 5 feet or less
  - Any immediately dangerous to life or health (IDLH) atmosphere

Target Gases and Effects

- Oxygen*
  - Must be between 19.5% and 23.5% by volume for atmosphere to be considered safe*
  - Above 23.5% by volume the environment becomes unstable and prone to flash fires or explosion
  - Below 16% physical effects will become apparent
- Methane
  - Colorless
  - Odorless
  - Non-toxic
  - Asphyxiate (displaces O2)
  - Lighter than air*
  - Explosive range (5% to 15%)

Target Gases and Effects

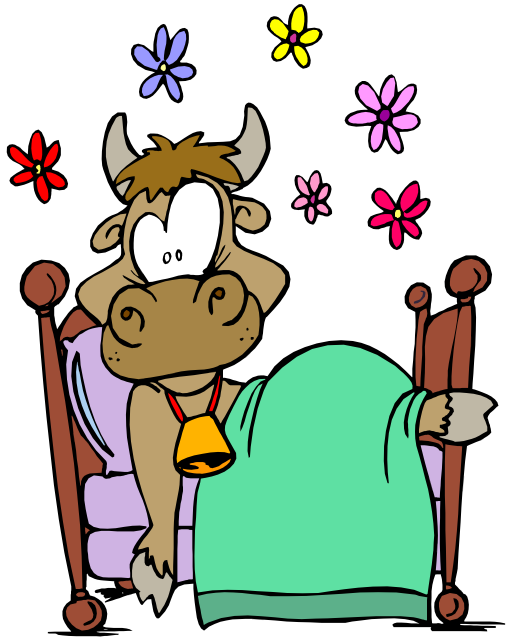
- Carbon Monoxide*
  - Colorless
  - Odorless
  - Toxic
  - Asphyxiant (displaces O_2)
  - Vapor density = to air
  - Explosive range (12.5% to 74.2%)

Target Gases and Effects

- Hydrogen Sulfide*
  - Colorless
  - Smell like rotten eggs
  - Toxic
  - Vapor density is 1.89
  - Explosive range (4% to 44%)
  - Common in sewage facilities
  - Diminishes your sensitivity to smell
- Sulfur dioxide
  - Pungent
  - Irritating gas
  - 1-10 ppm exposure causes respiratory and pulse rate increase and decrease in depth of respiration
  - Vapor density is 2.26
  - Non-flammable

Target Gases and Effects

- Carbon dioxide
  - Colorless
  - Odorless
  - Non-combustible gas
  - Toxic
  - Exposure symptoms
  - Headache
  - Dizziness
  - Restlessness
- Vapor density is 1.53



Atmospheric Monitors

- Types of air monitors/alarms
  - Single gas monitors
    a) Will monitor only one preset gas
  - Multiple gas monitors
    a) Will monitor multiple preset gases
       1) Monitors that sense four (4) gases at once are commonly used in confined space operations referred to as four (4) in one (1) monitors

Monitoring Operations

- Monitoring should be done in the following order every time
  - Oxygen content (first)*
  - Flammable gases/vapors (second)*
  - Potential toxic contaminants (third)*
- Testing should be done prior to lifting person hole covers
  - To get the most accurate reading
  - To eliminate potential explosions
- Testing should be done at all levels of the confined space
  - Stratification of gases may occur due to vapor density of gases vary
- Testing must continue periodically
- Results of monitoring must be logged
  - An entry permit as well as data log of monitor if equipped

Physical Hazards

- Grinding equipment*
- Agitators
- Mulching equipment*
- Drive shafts
- Gears and other moving equipment
- Steam or steam fittings
- Electrocution
- Falling objects*

Engulfment Hazards

- Material involved in engulfment incidents*
  - Grains
  - Sand
  - Gravel
  - Cement
  - Clay
  - Sawdust
  - Liquids
- Causes of engulfment incidents
  - Walking on unstable material that has void spaces below
    - Bridging*
  - Improper or lack of use of safety/retrieval lines
  - Overhead flow of particulate matter or liquids activated inadvertently

Case Study

On June 6, 1998, a 56 year-old worker died when he was engulfed by sand in a hopper at a concrete pipe manufacturing company. His job as a "material man" was to direct the flow of sand and gravel from storage bins to hoppers housed in a shed on top of the plant. Since there was only one conveyor that moved sand and gravel from storage bins to the shed, the material man had to enter the shed and manually operate a lever that controlled the flow of sand or gravel into the correct hopper. He entered the 17 foot deep hopper filled with sand, perhaps by falling, was engulfed, and suffocated.

Case Study

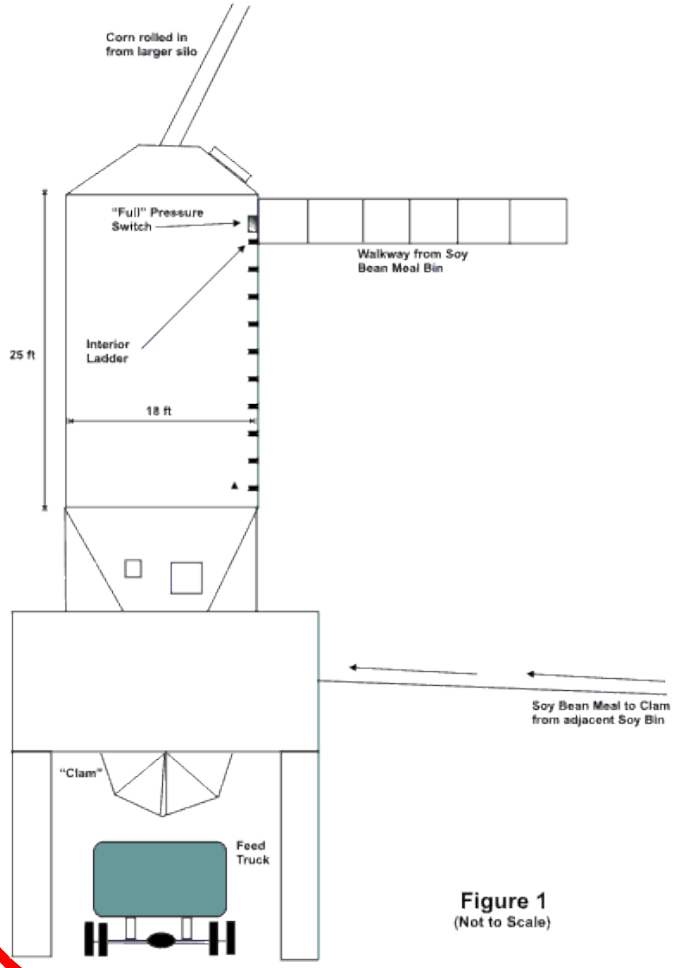


Figure 1
(Not to Scale)

A 23-year-old mill operator and a 20-year-old maintenance technician were killed when they were engulfed in corn in a 6,000 bushel cone bottom gravity feed bin at a feedlot. The two individuals had been "knocking down" soy bean meal in a gravity feed bin next to the corn bin prior to the incident. For some reason, after their work in the soy bean meal bin they went to the corn bin and both individuals became engulfed in cracked corn. Both of these bins were active, flowing soy bean meal and cracked corn into a "clam" approximately once every five to ten minutes. The "clam" was then emptied into feed trucks. When the corn flowed from the bin, this pulled the victims under the corn. When others at the feedlot realized the two were trapped in the corn, they cut openings in the bottom of the bin to release the corn and rescue the victims. Both individuals died from suffocation.

Target Industries

- Physical and engulfment hazards
  - Industry with mechanized assembly equipment
  - Spaces with electrical, hydraulic or pneumatic equipment supplied to it, or within it
  - Grain or particulate matter production or processing
  - Industries that have spaces with top load applications
  - Industries that have spaces with bottom dump applications

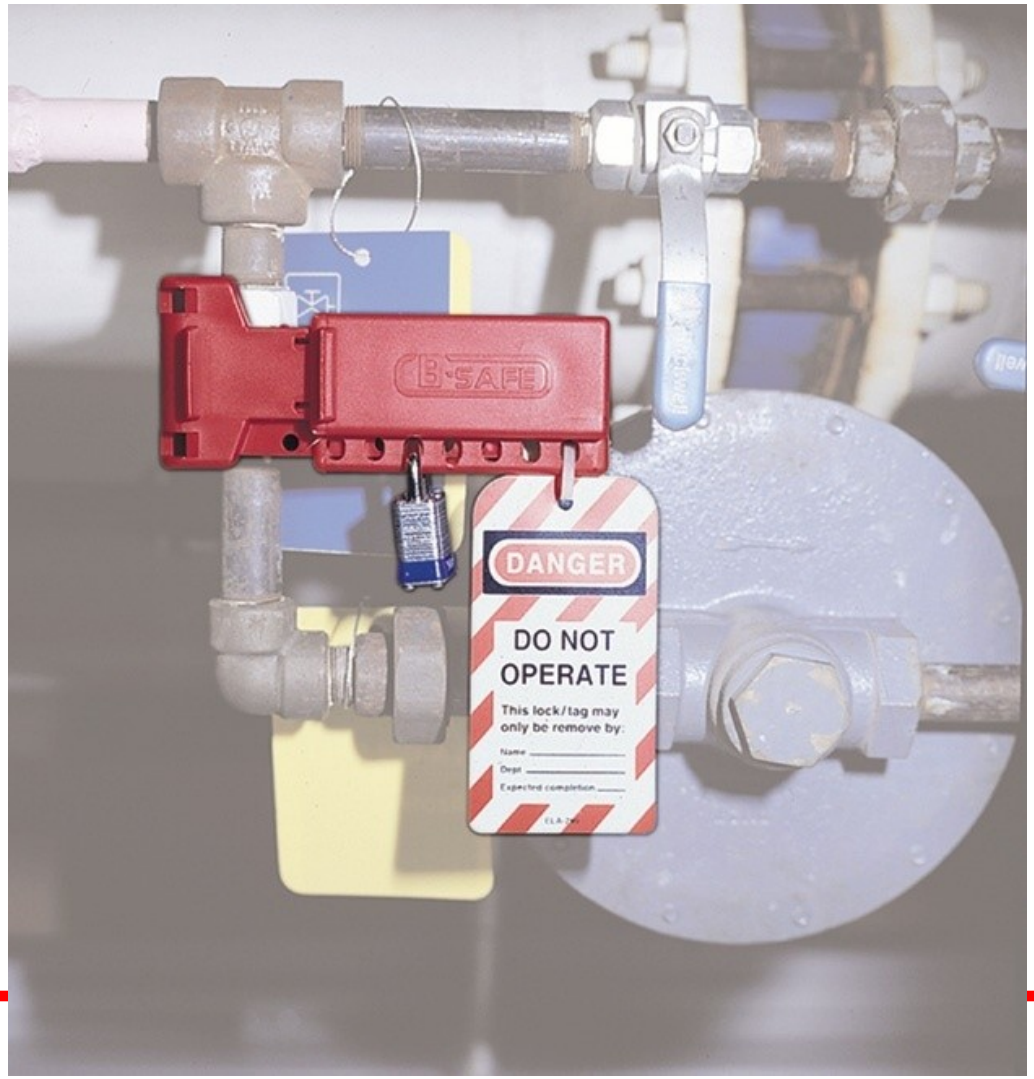
Lock-Out/Tag-Out Procedures

- Procedures performed to isolate any potential energy source to the space
  - Electricity
  - Hydraulic
  - Steam
  - Drive mechanisms
  - Pneumatic
  - Gravity flow of product
- Must be Performed by an authorized employee*
- Printed tags and locks are used to warn other employees of isolated energy source

Lock-Out/Tag-Out Procedures

- Examples of lock-out/tag-out*
  - Electrical switches locked-out
  - Hydraulic lines blocked and bled
  - Steam line blind flanged
  - Drive mechanisms disconnect
  - Drive belts removed
  - Liquid valves locked-out
  - Overhead dumps locked-out

Lock Out Tag Out



Entry Permits

- A form or tactical worksheet required by CAL-OSHA that must be completed for confined space entries
- Components of an entry permit
  - Location
  - Purpose of entry
  - Date of entry and authorized duration
  - List of authorized entrants
  - List of attendants
  - Entry supervisor signature
  - List of necessary tools and equipment
  - List of special hazards
  - Results of initial and periodic atmosphere tests
  - Measures to isolate the space and control hazards prior to entry
    - Lock-put/tag-out
  - Listing of rescue and emergency services
  - Communications procedures
  - Additional

Lock Out Tag Out

Always lock out and tag out circuits.

Entry Permits

- Prior to entry to entry supervisor must
  - Approve the permit *
- Upon completion of entry
  - Permit must be signed and cancelled by the entry supervisor *
  - Permit must be filed and retained at least one (1) year *

OSHA Exemptions to Permit Regulations

- Selected construction operations
  - Defined by section 1502
- Selected agriculture operations
  - Defined by Section 3437
- Marine terminal operations
  - Defined by Section 3460
- Shipyard operations
  - Regulated by Section 8437
- Telecommunications people holes and vaults
  - Regulated by Section 8616
- Grain handling facilities
  - Defined by Section 5158
- Electric utility operations within underground vaults

OSHA Exemptions to Permit Regulations

- Exemptions based on employer proof of atmospheric hazard only
  - Must not contain any other hazards except atmospheric condition only
  - Hazard can be eliminated by ventilation alone
- When exemptions are granted components of the normal entry program may or may not be present
  - Entry permit may not be provided
  - Attendant my not be present
  - Entrant lowering and retrieval equipment may not be present
- Exemptions are only valid when entry is for the prescribed purpose
  - To evacuate an injured worker out of an exempted space would nullify the exemption, and Sections 5156, 5157 and 5158 would prevail.

Ventilation Equipment & Technique

- Ventilation Equipment
  - Industrial fans/ventilators*
  - Smoke ejector fans*
  - Duct work*
  - Person hole saddle vents*
- Ventilations Plans
  - Ventilations plans are predominantly carried out in one of three ways
    - Forced supply ventilation*
    - Force exhaust ventilation*
    - Force supply and exhaust ventilation*

Ventilation Equipment & Technique

- Ventilation Plan Considerations
  - Configuration of the space
  - Number of openings in the space
  - Location of the openings
    - Vertical (top)*
    - Horizontal (side)
    - Bottom
    - Vapor density of suspected vapors*
    - Wind direction *
    - Equipment available

Ventilation Equipment & Technique

- Ventilation Plan Hazards
  - Directing exhausted explosive vapors toward ignition sources
  - Directing vehicle exhaust (or other hazardous vapors) into the supply fans
  - Changing a non-explosive atmosphere into an explosive atmosphere*
    - Diluting an atmosphere that is above its UEL down below its explosive range would require passing through the explosive range

Confined space
entry equipment

Respiratory Equipment and Techniques

- Respiratory Protection Requirements
  - Respiratory protection must be provided and personnel trained if the following conditions exist
    - Testing demonstrates the existence of dangerous or deficient conditions and additional ventilation cannot reduce concentrations to safe levels
    - The atmosphere tests as safe but unsafe conditions can reasonably be expected to develop
    - It is not feasible to provide for ready exit from spaces equipped with automatic fire suppression systems and it is not practical or safe to deactivate such systems
    - An emergency exists and it is not feasible to wait for pre-entry procedures to take effect

Respiratory Equipment and Techniques

- Respiratory Protection Classifications
  - Self-contained breathing apparatus
    - Considered highest level of protection
    - Supply / duration is carried with entrant*
    - No air hoses to outside to restrict movement*
    - Cylinder size can cause difficulty in tight spaces*
  - Combination/dual purpose SCBA
    - Same as simple SCBA with addition of high press inlet hose

Respiratory Equipment and Techniques

- Supplied air respirator with escape cylinder
  - Air is supplied to entrants mask from outside the space
  - Capable of endless air supply
  - Must include escape cylinder *
    - Normally five (5) to ten (10) minute duration
  - Air line not to exceed 300’ from source *
- Air purifying respirators
  - Must not be oxygen deficient atmosphere
  - Cartridge must be specific to vapor, mist, fumes, dusts, et.
  - Not recommended unless conditions are known and can be maintained *

Air Purifying Respirator

Air Purifying Respirator

Supplied Air Respirator with Escape Cylinder

Self Contained Breathing Apparatus

Communications Equipment

- Battery operated portable radios
  - Push to talk operations
  - Voice activated operations *
  - Ear mike option
  - Two way – multiple users
  - Reception/transmission interference
  - Electronic equipment must be intrinsically safe
- Hard wire systems
  - Push to talk operation
  - Voice activated operations *
  - Ear mike option
  - Conference operation – multiple users
  - Hard wire can restrict movement *
  - Electronic equipment must be intrinsically safe

Communications Equipment

- Hand signals
  - Basic signals
  - Must be committed to memory
  - Must have visual contact
- Rope signals
  - Basic signals
  - Must be committed to memory
  - Restricts movement
- Tapping or rapping codes on tanks
  - Basic codes
  - Must be committed to memory
  - Limited application

CAL-OSHA Regulations

- Permit required confined spaces
  - Communication equipment and procedures to maintain contact between entrants and attendants must be provided *
- Permit required confined spaces with any of the following conditions
  - Testing demonstrates the existence of dangerous or deficient conditions and additional ventilation cannot reduce concentrations to safe levels.
  - The atmosphere tests as safe but unsafe conditions can reasonably be expected to develop
  - It is no feasible to provide for ready exit from spaces equipped with automatic fire suppression systems and it is not practical or safe to deactivate such systems
  - An emergency exists and it is not feasible to wait for pre-entry procedures to take effect

OSHA Requirements: Retrieval Equipment

- OSHA requires retrieval line and fall restraint when vertical entry of five feet or more below grade is made *
- Retrieval lines must be attached to a mechanical device (mechanical advantage) outside the space
- Entrants are to stay “on line” unless this would increase entrant risk of injury, or is impossible *
  - Staying on line allows for non-entry rescue

Lifting, Lowering and Fall Restraint Equipment

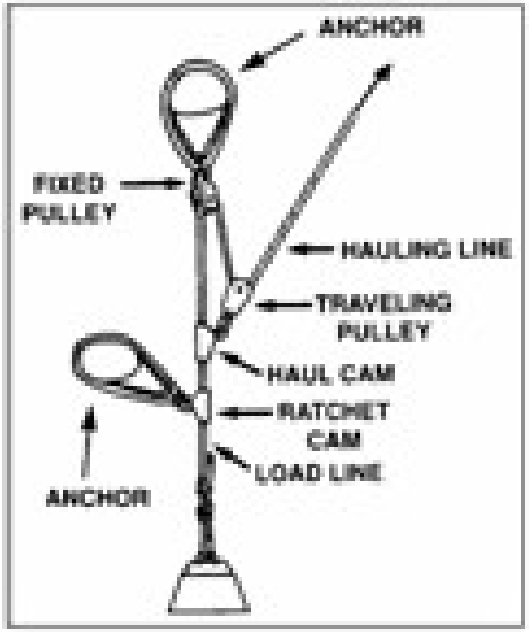
- Anchoring devices (high point anchor)
  - Tripod
    a) Manufactured
    b) Fabricated
       - Ladders
       - Timber
  - Ladder gin
  - Davit mounted systems
  - Truck mounted booms
  - Beam trolley

Tripod System

Ladder Gin

Mechanical Advantage System

- Z-Rig 3 to 1 pulley system



Lifting, Lowering and Fall Restraint Equipment

- Mechanical advantage systems
  - Hand cranked mechanical winches with cable
  - Rope and pulley systems
- Fall restraint systems
  - Inertia or centrifugal systems
    a) Maximum 2’ drop allowed
  - Cam systems
    a) Gibbs ascender
    b) Rescue ascenders

Lifting, Lowering and Fall Restraint Equipment

- Entrant/victim harnesses
  - Full body harnesses (Class III)*
  - Wristlets *
  - Upper body immobilization devices
    a) LSP halfback
    b) Oregon Spine Splint
  - Full body immobilization devices
    a) Stokes litter
    b) Sked sled
  - Miscellaneous hardware
    a) Pulleys
    b) Carabiners

Spinal Immobilization Devices

Operational Positions and Responsibilities

- Attendant Duties *
  - Knows hazards faced during entry, including mode, signs/symptoms and consequences of exposure
  - Understand behavioral effects of exposure on entrants
  - Maintains count and identities of personnel in the space*
  - Remains outside the space until relieved, may also perform rescue if trained
  - Communicates with entrants as needed *
  - Monitors activities inside and outside the space and orders evacuation if conditions dictate
  - Initiates on-site rescue procedures and summons additional rescue services if needed
  - Secures a safe perimeter and takes action if unauthorized persons approach *
  - Performs non-entry rescues or other rescue services as designated by the on-site rescue procedure
  - Performs no duties that might interfere with primary duty to protect the entrant

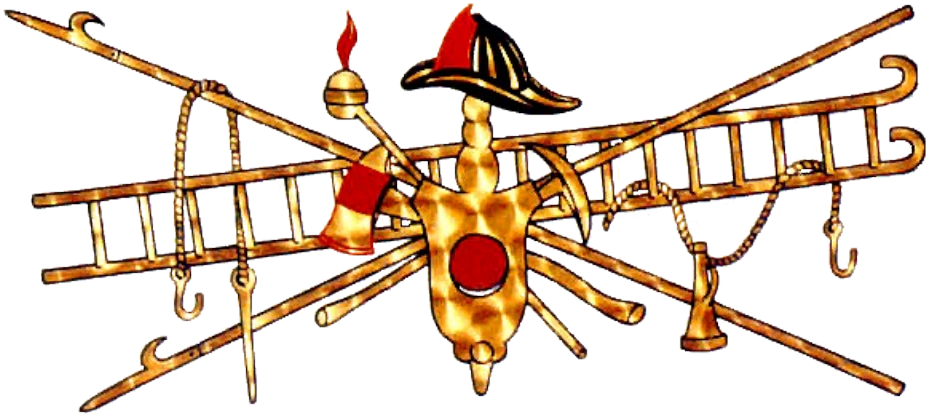
Operational Positions and Responsibilities

- Authorized Entrants Duties *
  - Knows hazards during entry, including mode, signs/symptoms and consequences of exposure
  - Properly uses all equipment required to make safe entry
  - Communicates with attendant as necessary for attendant to monitor entrant status and activate evacuation
  - Alerts attendant if situations warrant
  - Exits the space immediately if situations warrant

Operational Positions and Responsibilities

- Duties of Entry Supervisors *
  - Knows hazards during entry, including mode, signs/symptoms and consequences of exposure
  - Verifies that entry permit is completed, tests have been conducted, and needed equipment is present before endorsing the permit and approving entry*
  - Terminates the entry and cancels the permit *
  - Verifies that additional equipment and services are present
  - Confirms that entry operations remain consistent with entry permit, that acceptable entry conditions are maintained, and consistent transfer of responsibility take place *

Confined Space Awareness



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